image from atmospheric defects being the *main* cause of the difficulty.

Turning to another allied subject, the photographs of the Solar Eclipse, Mr. De La Rue referred to certain discrepancies (to which he had alluded in his Bakerian Lecture on the Total Solar Eclipse of 1860, read before the Royal Society), between the photographs taken by Father Secchi and his own, and stated that, on a recent visit to the Roman Observatory, he remarked a photograph differing considerably from those which have been distributed in this country, by the kindness of Señor Aguilar, who had accompanied Father Secchi. Father Secchi's copy bore a very much greater resemblance to Mr. De La Rue's than these latter; and, upon inquiry, he found that after the first few positives had been taken from the original negatives, they had been subjected to a process technically called "strengthening," which, in this instance, had completely blotted out all the minute detail at first recorded.

While Mr. De La Rue was in Rome, Father Secchi's copy of the first place of totality was enlarged, and he brought back with him to England a negative corresponding in size with those taken with the Kew Heliograph by himself; and he has found, on tracing both and comparing the tracings, that the similarity is complete, with the exception that two luminous prominences are seen in Father Secchi's photograph which were not visible from Mr. De La Rue's station; that is, the only discrepancies between the two photographs taken at the two stations could be explained by the greater covering of the Sun in the one or other direction by the parallax of the Moon, dependent on the observers' positions, with respect to the central line of the eclipse. J. N. L.

Memorie Astronomiche. Del Prof. Donati. (Published in the Annals of the Museum at Florence, 1862.)

(*Abstract by S. M. Drach, Esq.*)

The first memoir, dated August 1860, is on the Striæ of Stellar Spectra. After quoting Fraunhofer, in Schumacher's *Astron. Abhand.*, Part. ii., 1823, and in Gilbert's *Annalen der Physik* (vol. lxxiv., 1823), on the spectra of stellar and planetary light rays, the author states that he used a large burning lens kept in the Museum since 1690, and whereon Targioni, Averani, and Sir H. Davy had experimented. This lens has a diameter of 0·41 metres, and a focal distance of 1·58 metres (15 and $62\frac{1}{2}$ inches). The lens was mounted parallactically on a movable stand: a piece with a fine slit was placed a short distance within the focus of the lens, through which the stellar rays passed. Within this lens-tube

is a cylindrical lens with its very short focus, coinciding with that of the great lens. The stellar ray then falls on a prism fixed on a graduated circle, to which is attached a small achromatic telescope (object-glass, aperture 0·024; focal distance 0·17 metre; eye-piece magnifies 12 times). There is also at the end of the great lens-tube an achromatic lens equal to the object-glass of the telescope. Thus the stellar rays are passed through the cylinder-lens, the tube-achromatic, the prism, and the telescope-lenses before reaching the observer's eye. In the focus of the achromatic telescope are two metallic bars, one fixed, the other movable by a micrometer-screw. A cylinder-lens was preferred to a simple slit, for the purpose of getting the two lateral segments of the fasciculus of rays, which are lost in the ordinary diaphragm. But as by changing the position of the star observed, as respects the direction of the optical axis of the collecting lens, we change the position of the focal straight line produced by the cylindrical lens, making it impossible to keep the said straight line always in the same position as regards the prism, the author placed a metallic lamina at a distance from the cylinder-lens, equal to the focal distance of the latter. In the said lamina is a thin longitudinal slit, through which one sees the light-line formed in the focus of the cylinder-lens; thus certifying, when that line is visible, that it is always in the same position relative to the prism.

The author then proceeds as follows:—

I observed by day the solar spectrum, placing over the great lens a cloth, so fixed that it transmitted only the requisite quantity of light, and fixed the prism *p* to correspond to one or the other of the solar striæ; then fixing the telescope, I turned the movable bar, till one of its limbs touched the said stria at its minimum, and I read the corresponding division of the micrometer-screw. Leaving everything in this state, I turned the great lens in the evening to the star I wished to observe, and by the micrometer-screw immediately obtained the position of the stellar striæ, referred to the solar one observed in the morning. Besides the position of the stellar striæ, I have tried to determine the extremes of the spectra themselves, for which see Table.* I denote the striæ of the stellar spectra by the Greek letters, α, β, γ, proceeding from the least refracted end of the spectrum. The unlettered striæ have not been measured, but simply estimated, as being very difficult. I have grouped separately the separate-coloured stars, giving in each group the first place to the most conspicuous striæ, and so in order; classifying them from Humboldt's *Cosmos*, and Schmidt, in *Astr. Nachr.* The Table indicates that the stellar striæ have a certain relation to the star's colour. Thus the white stars seem to have a family likeness; and so the yellow, orange, and red ones. There is

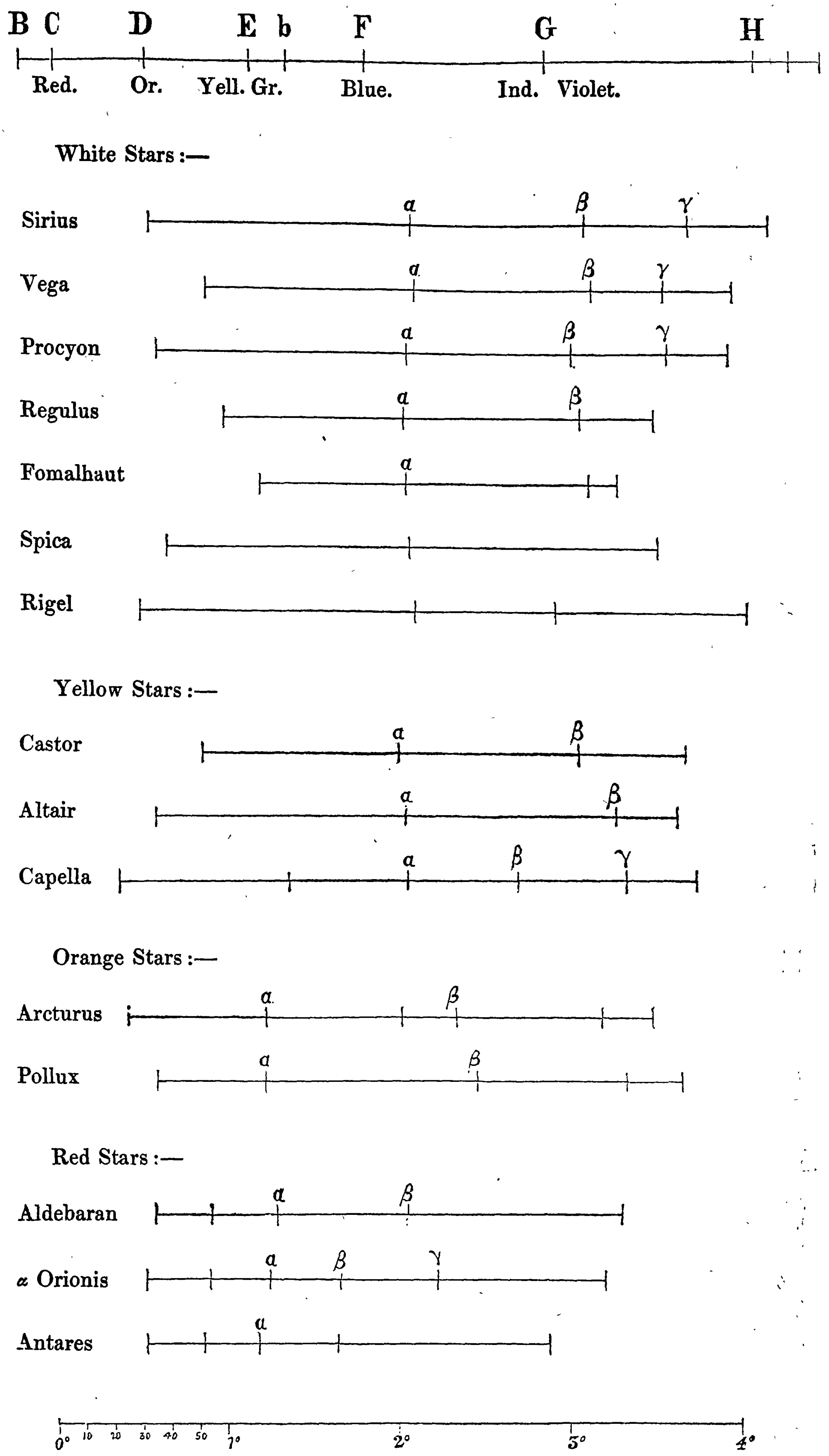
* See the figure, p. 103, roughly reduced from Prof. Donati's Memoir, and the numerical values, p. 104.—Ed.

likewise a great difference in the lengths. The three yellow stars have nearly the same maximum refraction end, but different minimum refraction ends; the reverse with the red stars. True, the measures of these ends (and indeed of the maximum refraction) are very uncertain, depending on the glass of the lenses and prism, and on the observer's eye. (Professor Amici has constructed a prism of very great dispersive power, without altering the axis of vision. It is composed of three prisms; the two outer ones of crown-glass, the inner one of boro-silicate of lead. Looking through this prism at a slit or luminous line, light is decomposed, with the same striæ as through a simple prism of flint-glass.) My prism was of flint-glass; refraction angle 60° 52′ 39″; angle of refraction of stria D of the solar spectrum (*i. e.* the angle which the refracted ray corresponding to D makes with the incident ray) is 49° 55′ 05″. The intermediate angles of the solar spectrum were found

BC = 10′ 57″	Eb = 7′ 45″	FG = 72′ 9″
CD = 30 35	bF = 29 16	GH = 65 56
DE = 40 41		

All these angles I have measured by the theodolite as accurately as possible. The rim of the micrometer-screw = 11′ 5″; each of the 100 divisions of the head = 6″·65. Its movable bar was broad enough to be seen without illuminating the telescope; and I always placed the same limb in contact with the measured striæ. I observed when the star was close to the meridian, giving me more definite striæ; but we must not conclude that the striæ change with the altitude of the star; the horizontal scintillations naturally disturb the precision of the spectrum. Whilst observing, I tried to be in the dark as much as possible; ordering another to read the micrometers; for when the eye is fatigued, even by the feeble light of a lantern, it could not perceive the feeblest striæ of the stars. In cloudy or moonlight nights, the observations were uncertain and sometimes absolutely impossible. Although the great lens was not achromatic, yet, looking through the telescope at the slit illumined by the rays collected by the cylinder-lens, it appeared perfectly white and without perceptible coloured edges.

The following measures are the means of many observations thus obtained. Each star has its stria α referred to the solar F. Thus, for *Sirius*, $\alpha = \mathrm{F}\odot - 15''$ means that *Sirius* α is refracted 15″ less than Sun F; and for *Vega*, $\alpha = \mathrm{F}\odot + 40''$, that *Vega* α is refracted 40″ more than Sun F. $(r\,\alpha)$ means the angle between the minimum-refracted end of the stellar spectrum with its stria α; $(\alpha\,\beta)$, $(\beta\,\gamma)$, the angles between α and β, β and γ. $(\alpha\,v)$, $(\beta\,v)$, $(\gamma\,v)$, are the angles made by α, β, and γ, with the maximum-refracted end v of its spectrum.


B C D E b F G H
Red. Or. Yell. Gr. Blue. Ind. Violet.
White Stars :—
Sirius
Vega
Procyon
Regulus
Fomalhaut
Spica
Rigel
Yellow Stars :—
Castor
Altair
Capella
Orange Stars :—
Arcturus
Pollux
Red Stars :—
Aldebaran
α Orionis
Antares
α β γ
0° 10 20 30 40 50 1° 2° 3° 4°

A short description of each stria is appended, and its eye-estimated breadth referred to the micrometric bars. These said angles do not correspond to the central part of the striæ, but to their least refracted limb, which limb I always collimated with the movable bar of the micrometer. Thus *Sirius* α is refracted 15″ less than F Sun; but, since breadth of this $\alpha = 50''$, the central part of the said α is refracted 10″ more than F Sun. Similarly *Vega* $\alpha = F \odot + 40''$, breadth 40″, has its centre refracted 60″ more than F Sun, &c.

		$(r\,\alpha)$	$(\alpha\,\beta)$	$(\beta\,\gamma)$	$(\gamma\,\vartheta)$
Sirius	$\alpha = F \odot - 15''$	85′ 40″	66′ 37″	42′ 27″	20′ 17″

α very fine, breadth 50″; β very fine, double, breadth 80″; γ as broad as α, faint.

Vega	$\alpha = F \odot + 40''$	77′ 15″	67′ 56″	34′ 55″	10′ 18″

α, β, very fine; α 40″, β 60″ broad; γ very broad, faint.

Procyon	$\alpha = F \odot - 33''$	78′ 55″	65′ 30″	37′ 1″	9′ 32″

α well seen, 15″ broad; β scarcely seen; γ ditto, rather broader than α.

Regulus	$\alpha = F \odot - 60''$	68′ 30″	66′ 17″	30′ 55″	—

α very clear, 20″ broad; β seen at intervals.

Fomalhaut	$\alpha = F \odot - 55''$	61′ 44″	70′ 36″	—	—

α fine, 35″ broad.

Castor	$\alpha = F \odot - 30''$	69′ 43″	62′ 4″	30′ 9″	—

α very fine, 40″ broad; β ditto, 60″ broad.

Altair	$\alpha = F \odot + 5''$	73′ 42″	66′ 3″	24′ 23″	—

α fine, 20″ broad; β indistinct, faint, 40″ broad.

Capella	$\alpha = F \odot - 2' 40''$	81′ 1″	31′ 55″	34′ 35″	23′ 36″

α very thin, well observed; β, γ, scarcely visible, uncertain observation.

Arcturus	$\alpha = F \odot - 29' 22''$	51′ 26″	44′ 27″	66′ 23″	—

α very thin, seen with trouble; β very difficult to be seen.

Pollux	$\alpha = F \odot - 28' 42''$	47′ 33″	45′ 46″	68′ 56″	—

α very thin, seen with trouble; β very difficult to be seen.

Aldebaran α = F ☉ − 22′ 29″	50′ 39″	29′ 40″	64′ 17″	—	

α very fine, 30″ broad; β somewhat thinner than α, very fine.

α Orionis α = F ☉ − 30′ 35″	50′ 19″	17′ 24″	16′ 51″	57′ 18″	

α very fine, 40″ broad; β very fine, 50″ broad; γ frothy, well seen.

Antares α = F ☉ − 33′ 28″	47′ 20″	18′ 17″	65′ 45″	—	

α fine, 30″ broad; β rather fine, 20″ broad.

Now, comparing my results with Fraunhofer, there are very great differences. Thus, he says, *Sirius* has a very fine stria in the green, whilst I find this stria in the blue of the spectrum. He finds in *Pollux*, *Capella*, *α Orionis*, *Procyon*, a stria with the same position as D Sun, which line I have never seen. Perhaps attributable to the reason that the stellar light is never strong enough to distinguish the colours; saving a reddish tinge at the minimum-refraction end, they appear of a lavender tint in their whole length, which is always smaller than the solar one under the same conditions, from the great difference of light between the Sun and stars. If the stellar stria has not been measured, but merely eye-estimated (probably Fraunhofer's process), one may very easily get deceived, and mistake one stria for another. This occurred even to me at the beginning. Thus comparing the distance between the extreme red of *Sirius* and its α with that between the extreme red of the Sun, and E ☉, I judged that α *Sirius* = E ☉; but, passing to exact measures, I directly found that α *Sirius* = F ☉.

Perhaps, as the stars change in colour, their stria-positions may change, or my more brilliant striæ may not have been the more brilliant ones to Fraunhofer's eye. (Thus Fraunhofer is silent on the difficulties of *Capella*, and speaks of the difficulties of *Procyon*. I found *Capella* very troublesome, and the stria of *Procyon* much clearer and sharper than any in *Capella*.) I merely point out the utility of making these observations at various times with the extremest accuracy, without hazarding any hypothesis.

However, I must remark that almost all my fifteen stars have a stria, very little differing from F ☉. One may therefore presume that all these F-like striæ are constant, but with a greater or less refraction, from a difference in the refractive quality of the light of the particular star. On this hypothesis (partly agreeing with Fraunhofer's), it follows that the light of *Capella*, with a stria refracted 2′ 40″ less than F ☉, must suffer a less refraction than the light of *Vega*, which is refracted 60″ more than F ☉, whence the declinations of those two stars,

observed from two places, with very different (meridian) altitudes for each, must result differently. (Since $2' \, 40'' + 60'' = 220''$, and the refraction of F $\odot = 51^\circ \, 13' = 3073'$, with an horizontal refraction of $33'$. Hence the different refractions of these two striæ transferred to horizontal refraction $= \frac{33}{3073} + 220'' = 2''\cdot36$). I, therefore, compared Mr. Airy's *Cambridge Observations*, 1828–1835, with Mr. Henderson's, at the Cape of Good Hope, 1832–3 (*Mem. R. Ast. Soc.* vols. x. and xi.), which give these results:—

Camb.—C.G.H. 1830.		Mean Declination. Camb. 1830·0.	C.G.H. 1833·0.	A.P.M. in Decl.
"		° ′ "	′ "	"
+1·94	Fomalhaut	−30 31 13·92	30 19·1	−0·166
+1·71	Antares	−26 0 46·81	3 14·3	−0·034
+0·81	Sirius	−16 29 22·22	29 36·2	−1·198
+1·12	Spica	−10 16 15·60	17 13·7	−0·040
+0·57	Rigel	− 8 24 16·22	24 2·9	−0·012
−0·06	Procyon	+ 5 39 14·65	38 48·5	−1·023
+0·28	α Orionis	+ 7 22 3·72	22 7·1	+0·002
+1·32	Altair	+ 8 25 33·75	25 59·6	+0·380
+0·07	Regulus	+12 47 44·17	46 49·1	+0·006
−0·51	Aldebaran	+16 9 35·68	9 59·6	−0·174
+1·43	Arcturus	+20 4 16·41	3 18·0	−1·983
+0·72	Pollux	+28 25 45·50	25 20·4	−0·057
+0·49	Castor	+32 15 9·44	14 47·2	−0·078
+1·88	Vega	+38 37 50·56	37 57·7	+0·282
−2·00	Capella	+45 48 52·88	49 8·4	−0·425

I have extracted the Annual Proper Motion from vol. ii. p. 199, of *Annals of the Paris Observatory*. With them and the values in p. 181, to calculate the Precession, I have reduced the Cape Observations to 1830·0, whence I find as above. Whence *Vega* has at Cambridge a greater Declination than at the Cape of Good Hope, and *Capella* a less Declination at Cambridge. This seems to agree with my supposition, since *Vega* is low at the Cape with great horizontal refraction, and at Cambridge it is very high, with scarcely any refraction; and since the light of *Vega* seems from the above to be refracted more than the light of any other star, the refraction correction used at the Cape (which would increase the declination) is too small, making the star's declination less than that observed at Cambridge. The same horizontalities being verified for *Capella*, but, as contrary to *Vega*, the light of *Capella* is less refracted than that of *Vega*, the refraction correction

for the Cape of Good Hope must be too great for this star, causing a greater Cape of Good Hope declination than at Cambridge, as is the case. I chose the above two Catalogues, as being much esteemed and in approximate years: thus eliminating the uncertain influences of stellar Proper Motion. Also the stria *Vega* α is very fine, and *Capella* α, though thin and difficult, has been often observed by me with sufficient precision. This does not occur with Fomalhaut, which, rising to a very small altitude above Florence, and only seen for a short time, has been seldom observed by me, causing with its horizontal scintillations unreliable results. Indeed, my observations would lead to a contrary sign of the difference in declination between Cambridge and the Cape of Good Hope than to that which is actually obtained.

The sign for *Sirius* should be +, since the centre of its α is refracted 10″ more than F $\odot$; the refraction correction applied to this star's observed place may be smaller than the true one, when the observed declination at Cambridge has not been increased enough, giving a smaller result at the Cape of Good Hope. The difference, *Altair* + 1″·32, also confirms my hypothesis; for, since the centre of its α stria is refracted 20″ more than F $\odot$, one may suppose the horizontal refraction to be less than the true one, causing the Cambridge declination to be increased, and the Cape of Good Hope declination diminished; and, therefore, the former greater than the latter.

My measures are uncertain, more from the difficulty of hitting the exact stria-point than from the micrometer graduation stopping at 6″·6. The quickest way of reconciling the two Catalogues would be to make simultaneous observations at both places.

I would further recommend for observations of the stellar striæ a very large lens on Fresnel's principles for lighthouse lenses, as we do not so much require an image of achromatic sharpness as the concentrating of a great quantity of light, and such a lens would, perhaps, enable us to see as many stellar striæ as we find in the solar spectrum.

We further require to know the very small dispersive power in our atmosphere of the stellar light; also the stellar spectra breadth seen when near the horizon by a good telescope; also the maximum brightness point of various spectra. Such a series would be of first-rate value to modern Astronomy.

The second Memoir, dated February 1861, contains the author's observations of the Total Solar Eclipse of 1860, at Terrablanca, in Spain; and the third Memoir contains the Comet Observations at Florence, from 1854 to 1860.
